



# **The Worldwide Importance of Pesticides for Crop Production**

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# **Tropical Export Crops**

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- **Bananas, cocoa, coffee, tea**
- **Perennial trees/bushes that cannot survive freezes**
- **Diseases, insects, and weeds flourish in the tropics**
- **Without pesticides, production would decline significantly**



# Bananas

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- 34 billion pounds exported annually
- Most popular fruit in the world



- Sigatoka fungal germ tube penetrating opening in banana leaf



Sigatoka-infected banana plants

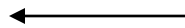


# Bananas: Sigatoka Disease

- Present in all banana growing countries
- In 1934, destroyed 22,000 acres of bananas in Central America
- Fungicide treatments began in 1936



Treated



Untreated







# Banana Export Plantations: Today



Fungicides are applied 25–35 times annually



# Pesticide Use Markets

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- **Highly developed (>90% acres treated)**
  - **US, Europe, Japan, Australia, Canada**
- **Developing**
  - **China, India**
- **Not Developing (<5% acres treated)**
  - **Sub-Saharan Africa**





# **Pesticide Use Driver: Developed Countries**

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- **Consumer demand for picture-perfect produce**



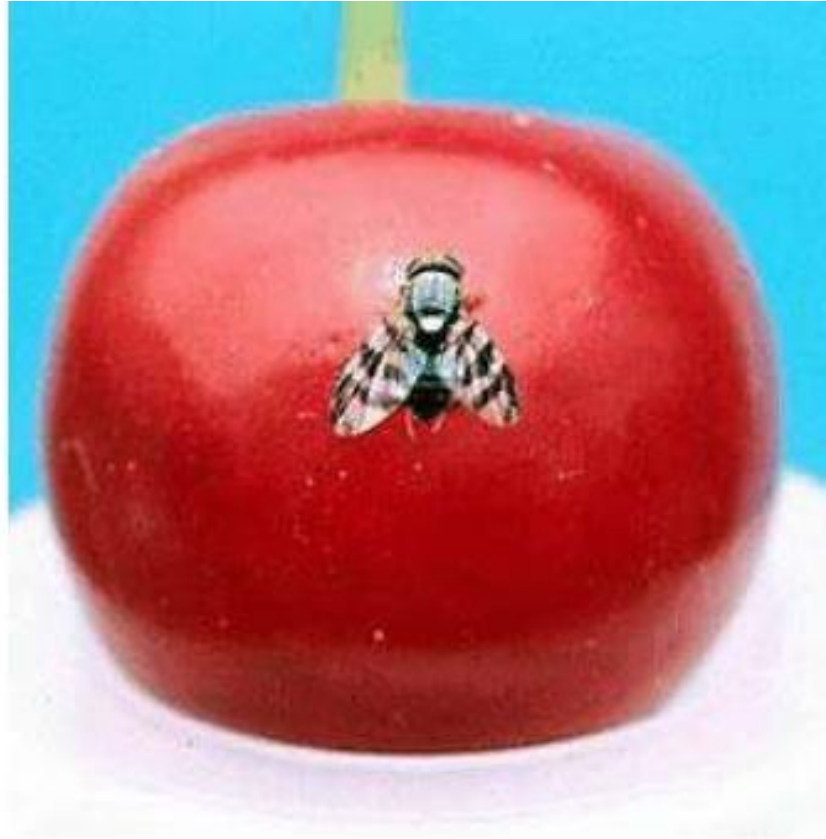
- **Consumers have zero tolerance for wormy apples**



U.S. apples have been sprayed with insecticides for  
over 100 years



# Cherry Fruit Fly





# Cherry Fruit Fly Larvae







# Supermarket Shopping Survey

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- **Two-thirds of respondents were willing to pay 5 – 10% higher prices for certified pesticide-free produce, yet were unwilling to accept any cosmetic defects or insect damage.**

ERS, USDA, 1990



# **Herbicide Use Driver: Developed Countries**

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- **Shortages of workers to weed fields starting around the 1950s-60s**
- **Herbicides greatly reduced the need for weeding by hand**



# California: Weeding Vegetable Crops 1940s – 1960s



**Thousands of legal temporary workers from Mexico  
in the *Bracero* (Strong Arm) Program**



# Hand Weeding

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**Millions of people weeded  
U.S. cotton fields into the 1950s**



# **Decline in Hand Weeding 1950s - 1960s**

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- **Millions of Workers Left Southern States for Urban Factory Jobs**
- **The *Bracero* program ended in 1964**
- **Hand Weeding Was Replaced with Herbicides**





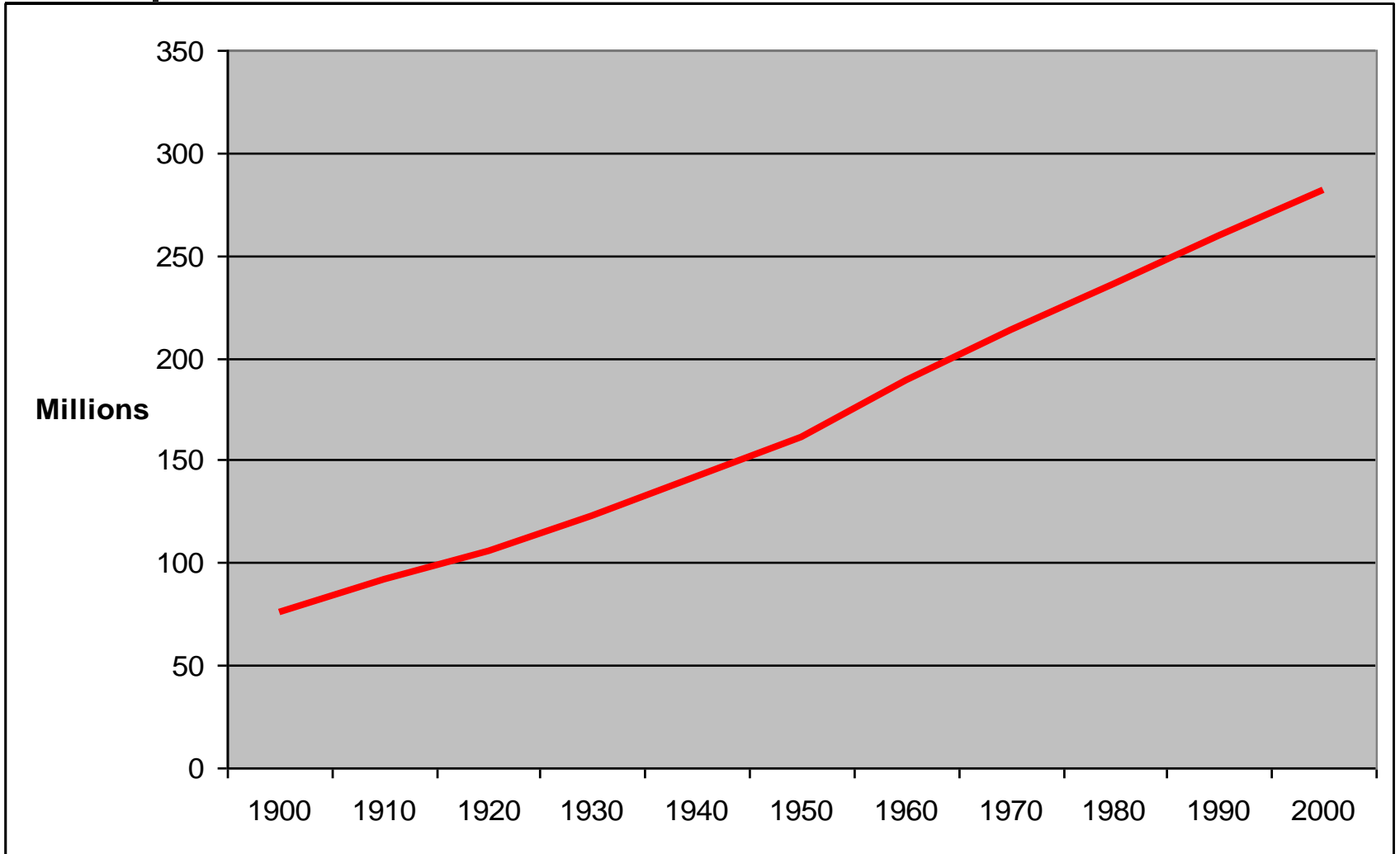
# **Pesticide Use Drivers: Developed Countries**

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- **Need to produce more food for growing populations**
- **Pesticides have effectively controlled pests leading to yield increases**

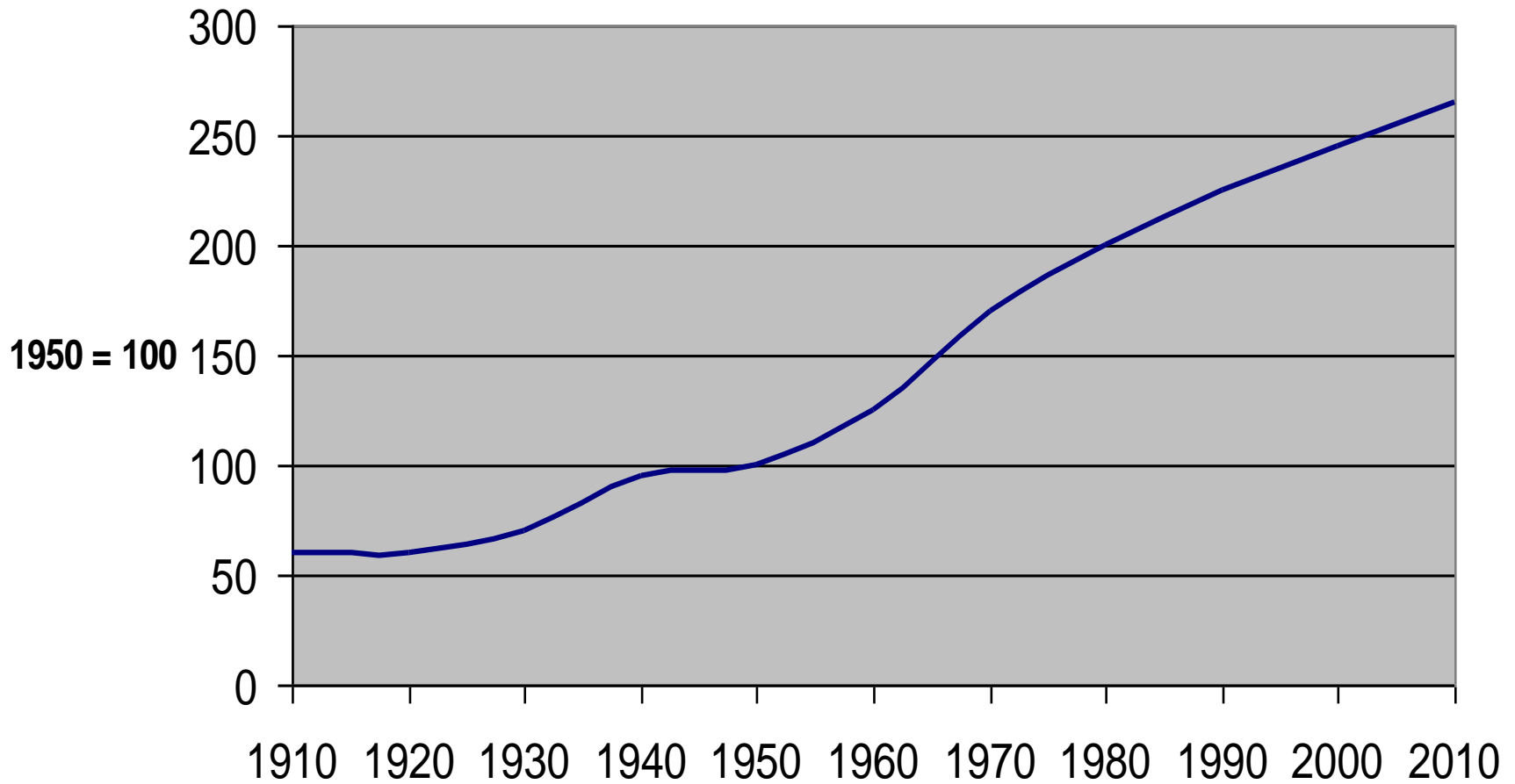


# U.S. Population, 1900 - 2000



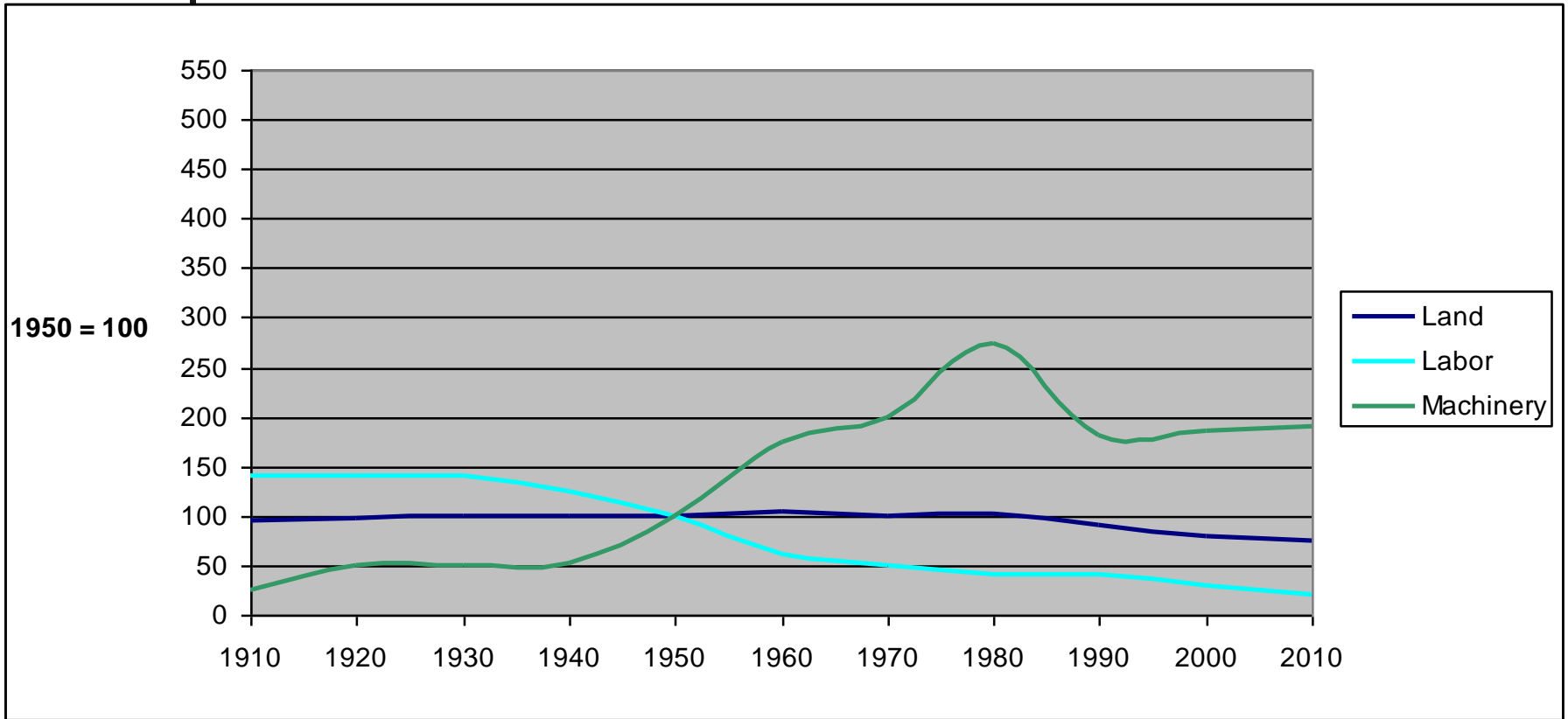


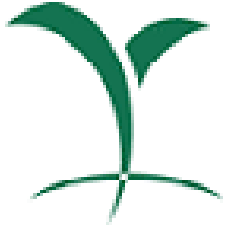
# U.S. Farm Output



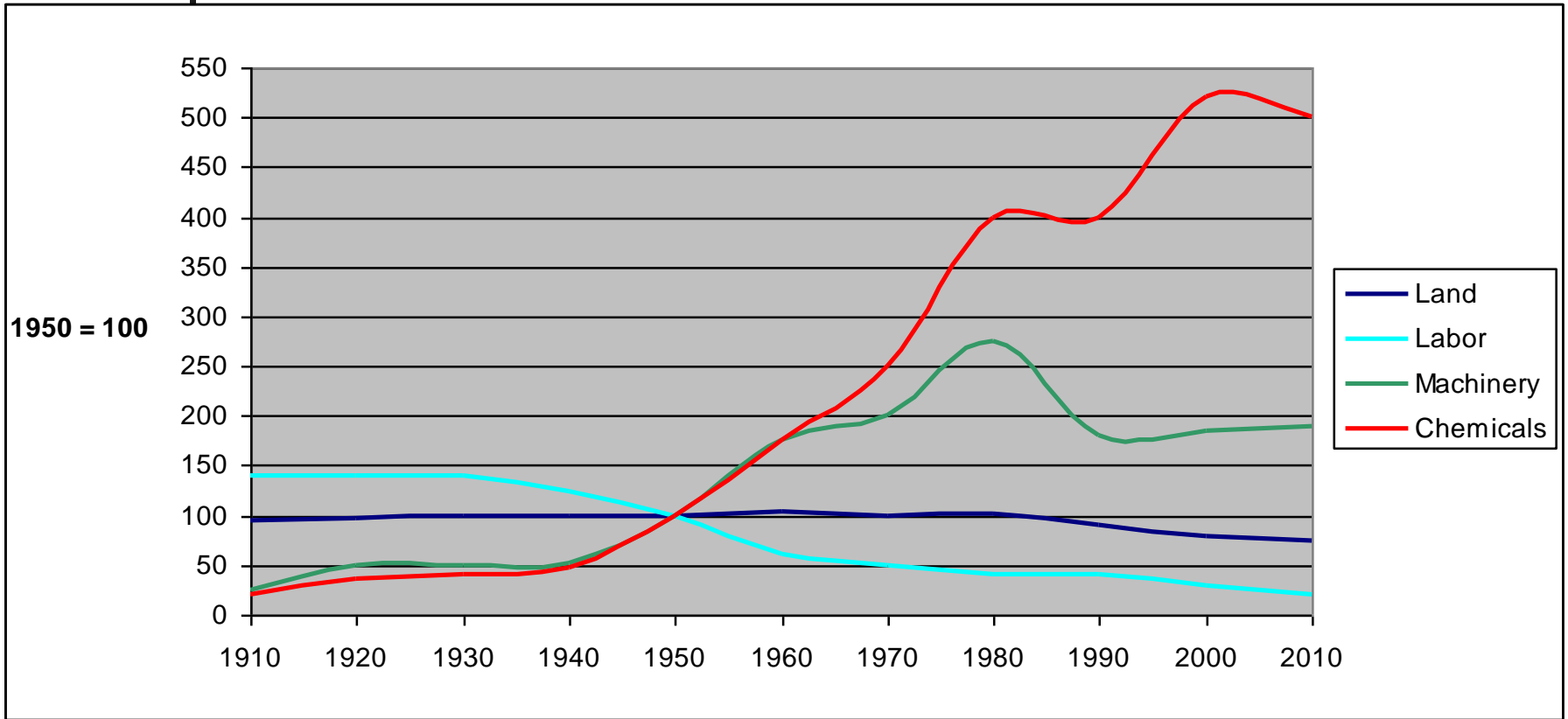


# U.S. Aggregate Farm Input Use





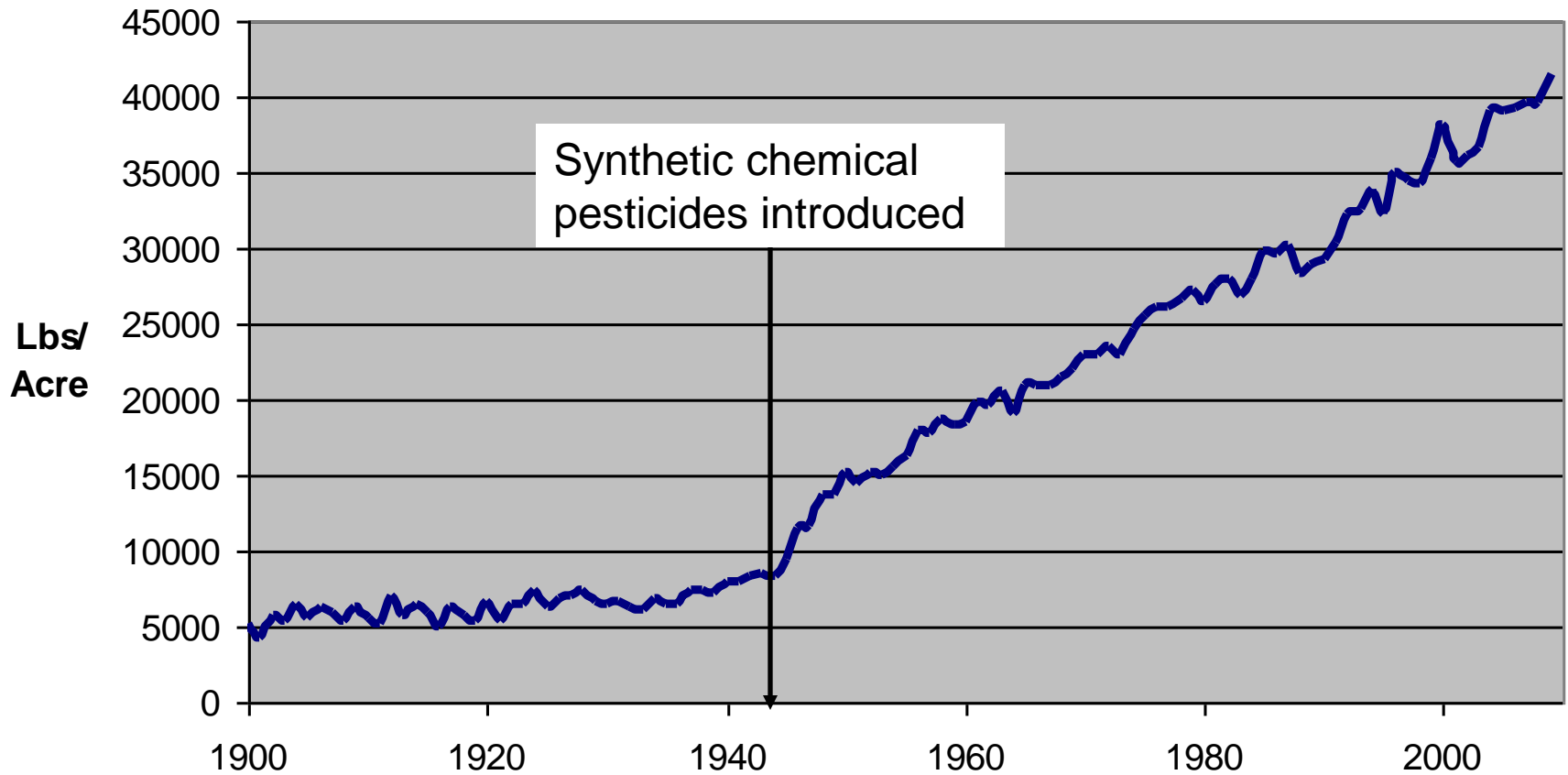
# U.S. Aggregate Farm Input Use







# Potato Yield: US





# **U.S. Rice: Weeds Not Well Controlled Before Herbicides**

**Untreated**



**Herbicide  
Treated**

- **Hand Weeders Not Used**



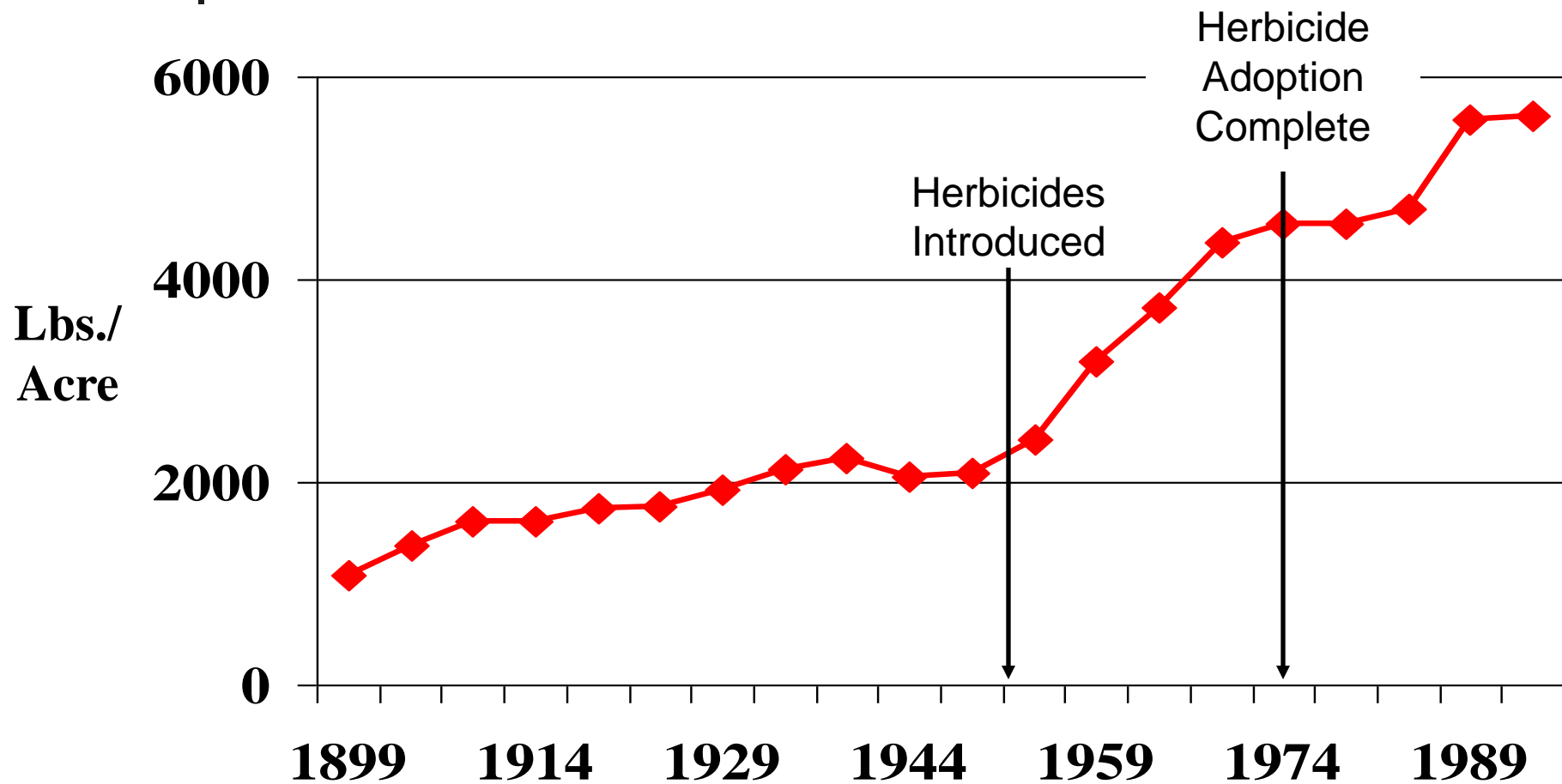
# Herbicide Application: Rice

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# U.S. Rice Yields





**Pesticides are used widely in agriculture in the United States. Their application has improved crop yields and increased the quantity of fresh fruits and vegetables in the diet, thereby contributing to improvements in public health.**

**NAS, 1993**





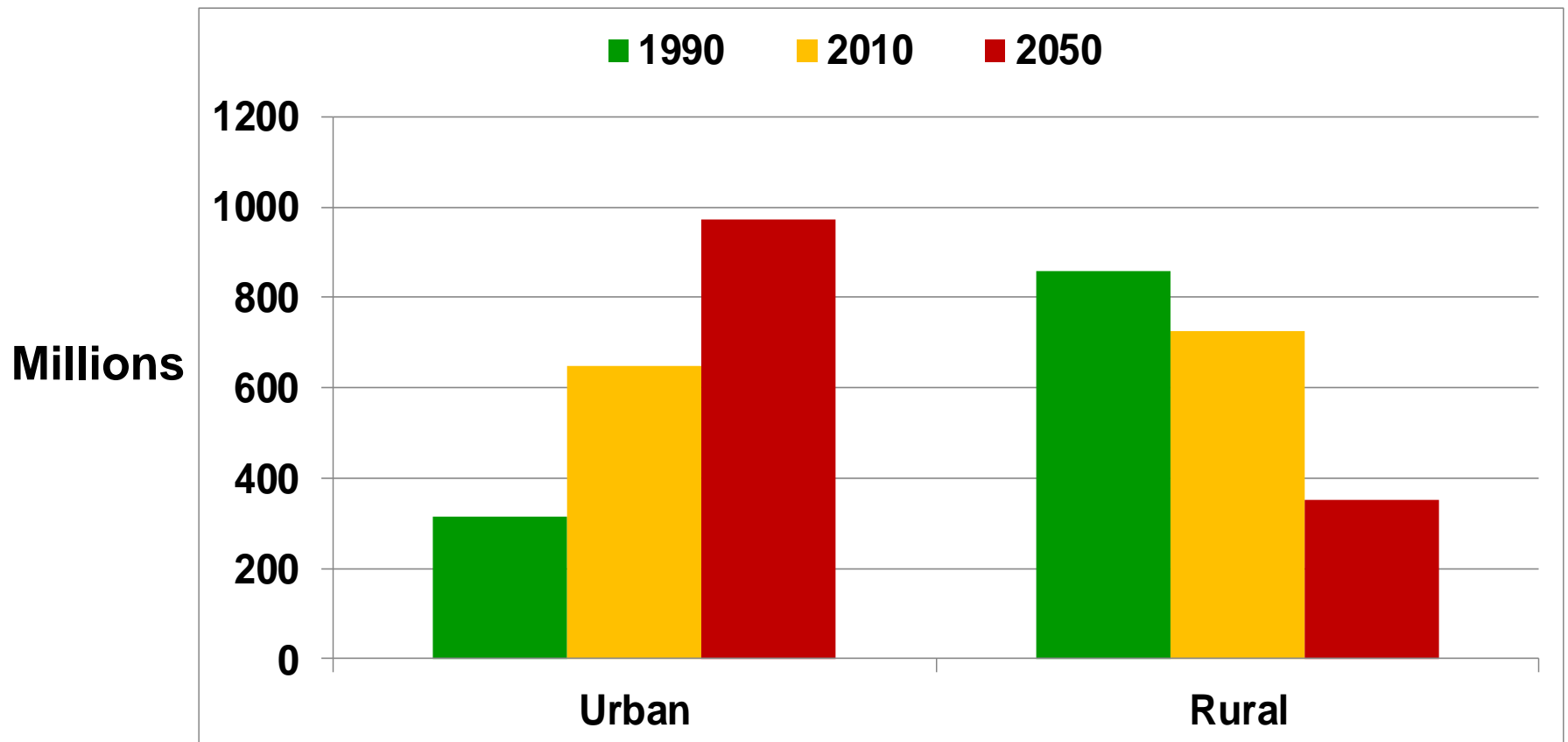
# **Feeding a Changing World**

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- **Increased Population**
- **Rapid Economic Growth**
- **Increased Urbanization**
- **Increased Middle Class**
- **Changing Diets**



# China's Population





# Weeding Rice, China



Adequate weeding of rice requires  
1 billion person days of labor



# Hand Weeding in China

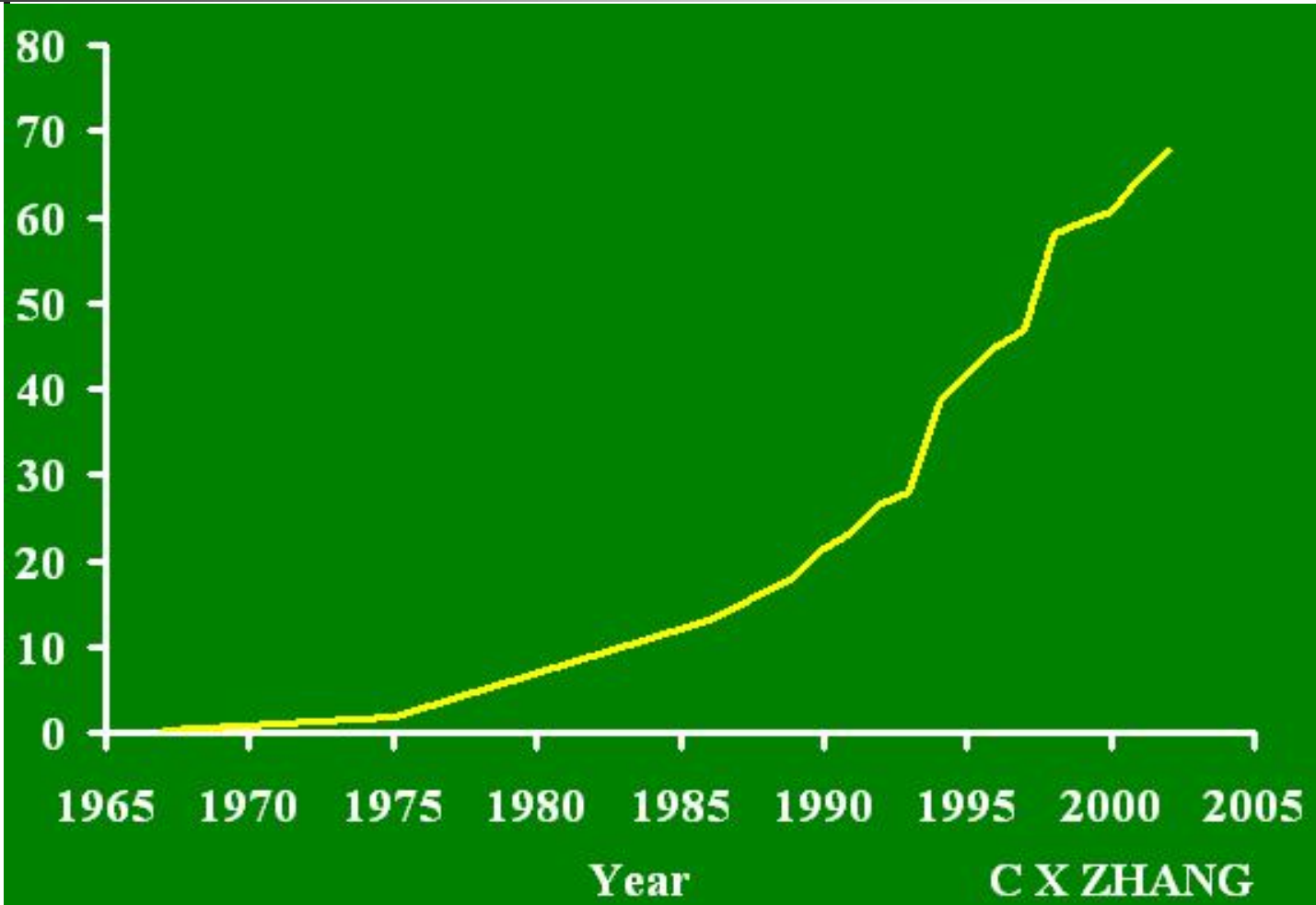


Millions of Farm Workers are Moving to  
Urban Areas



# Herbicide Use: China

Million  
Hectares







# China: Rice Field

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# Weeding Rice in India

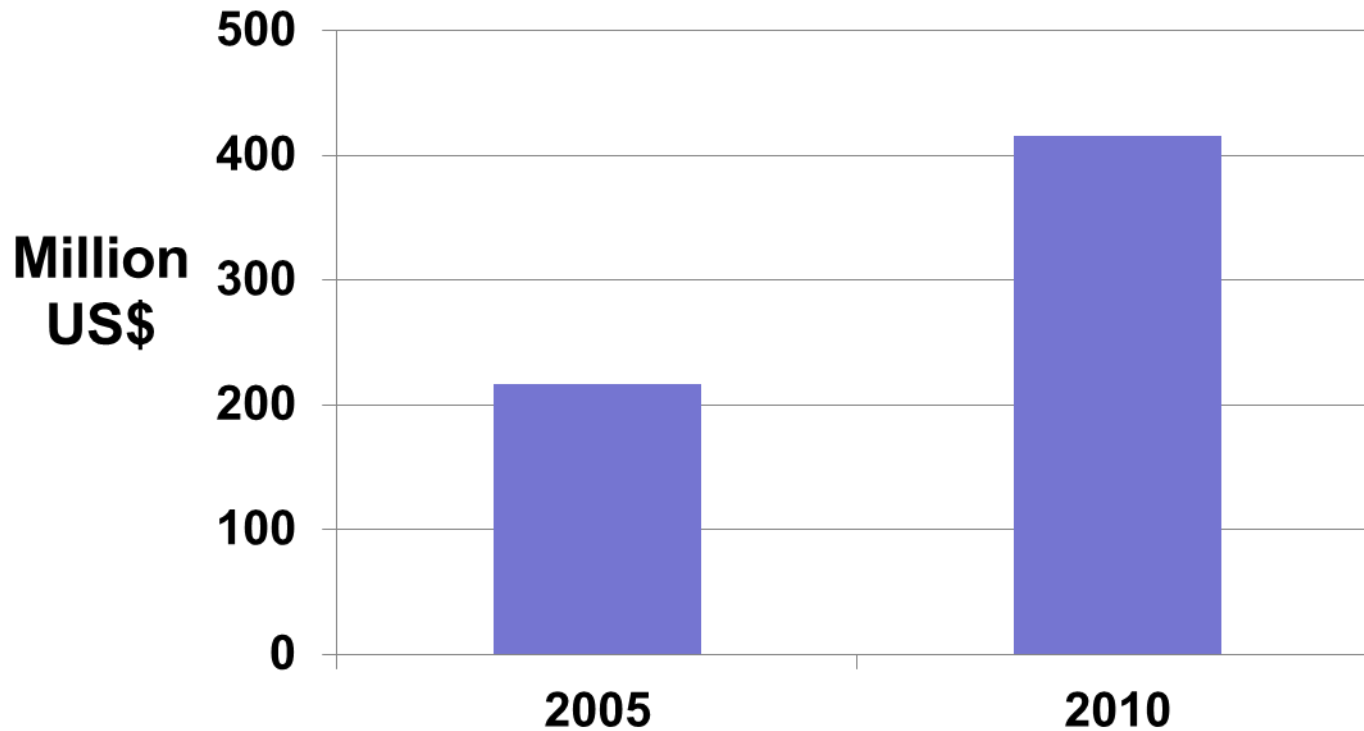


**Labor is becoming scarce**



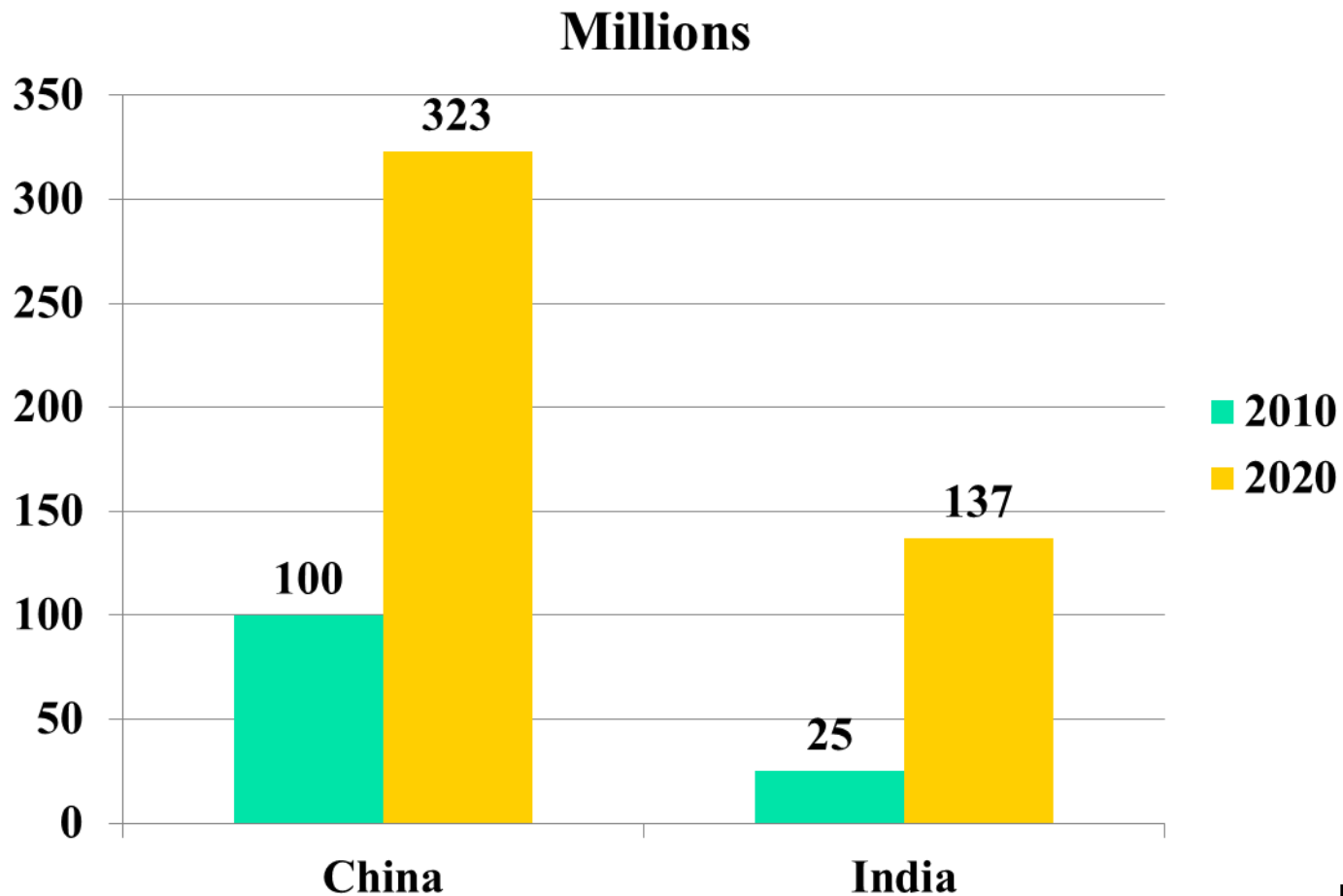


# India: Crop Herbicide Market



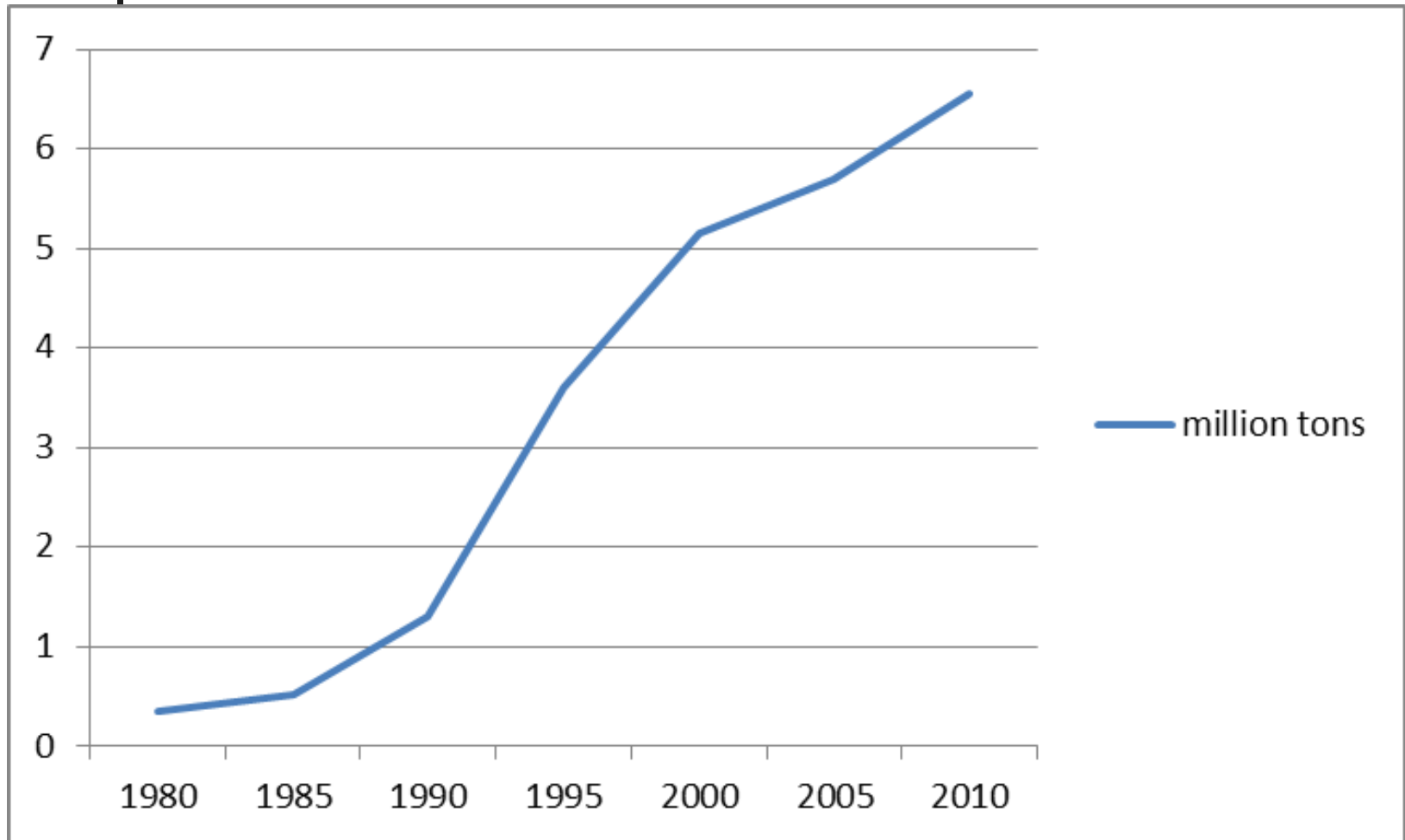


# Middle Class Households





# China: Beef Production





# **US Soybean Exports to China**

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- **895 million bushels/year**
- **50% of all US soybean exports**
- **25% of total US harvest**
- **50% of China's soybean imports**



# **U.S. Soybeans**

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**Since 1976, 95-98% of US soybean acres have been sprayed with herbicides for controlling weeds.**



## Weeds in Soybean Field

**Herbicide Treated**

**Untreated**







# Michigan State University: Research Trials



Cultivation of organic soybeans with 30 inch row spacing





# Cultivators

- **Can't be used in wet fields**
- **Weeds continue to grow**





# **Wisconsin Research: Weeds and Yields**

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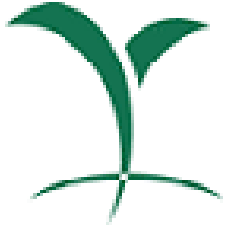
**The frequency of weed control problems and subsequent reduced yields in low-input row crops is roughly 34 out of every 100 cases and the corresponding relative yield is approximately 74%**



In the U.S. there is a perfect non-chemical alternative to herbicides.



Weeding a community garden

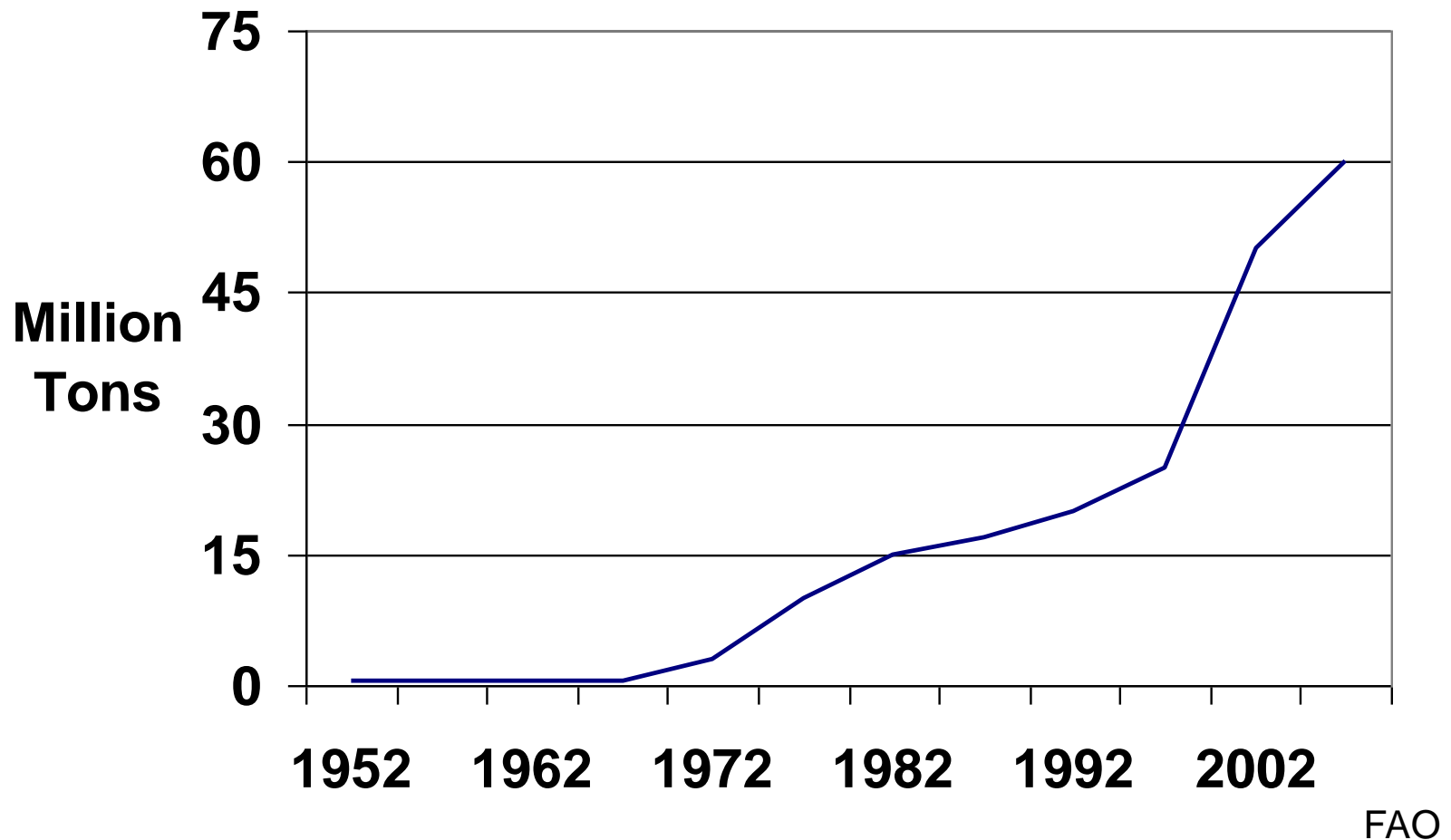


In the U. S. 70 million workers would be required for weeding to prevent yield losses without herbicides.

Gianessi and Reigner, 2007.



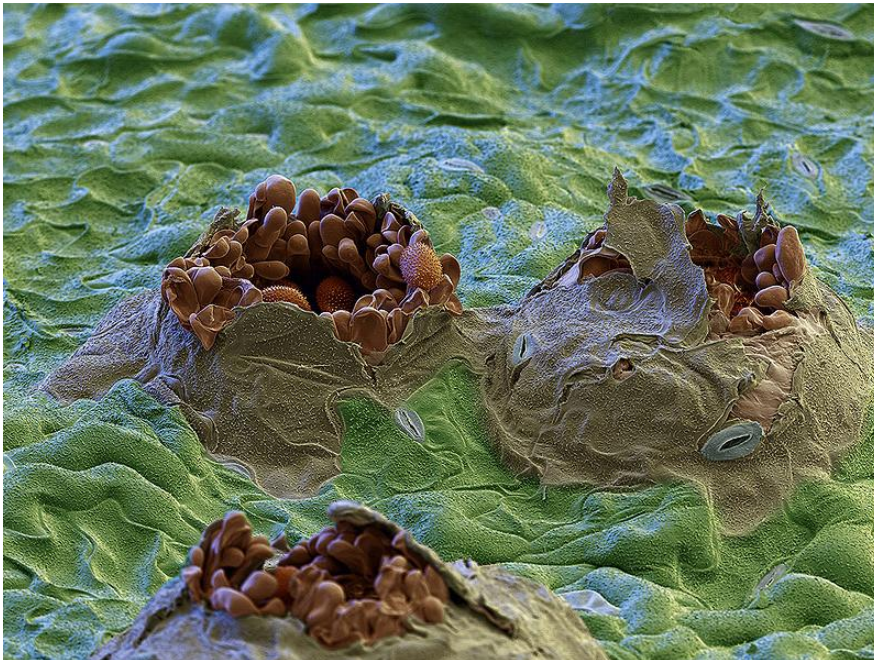
# Brazil: Soybean Production







# Soybean Rust Pustules



- **Brazil: First appeared 2001**
- **By 2003: Spread to entire country**
- **Yield losses up to 75%**

Yorinori, 2005.





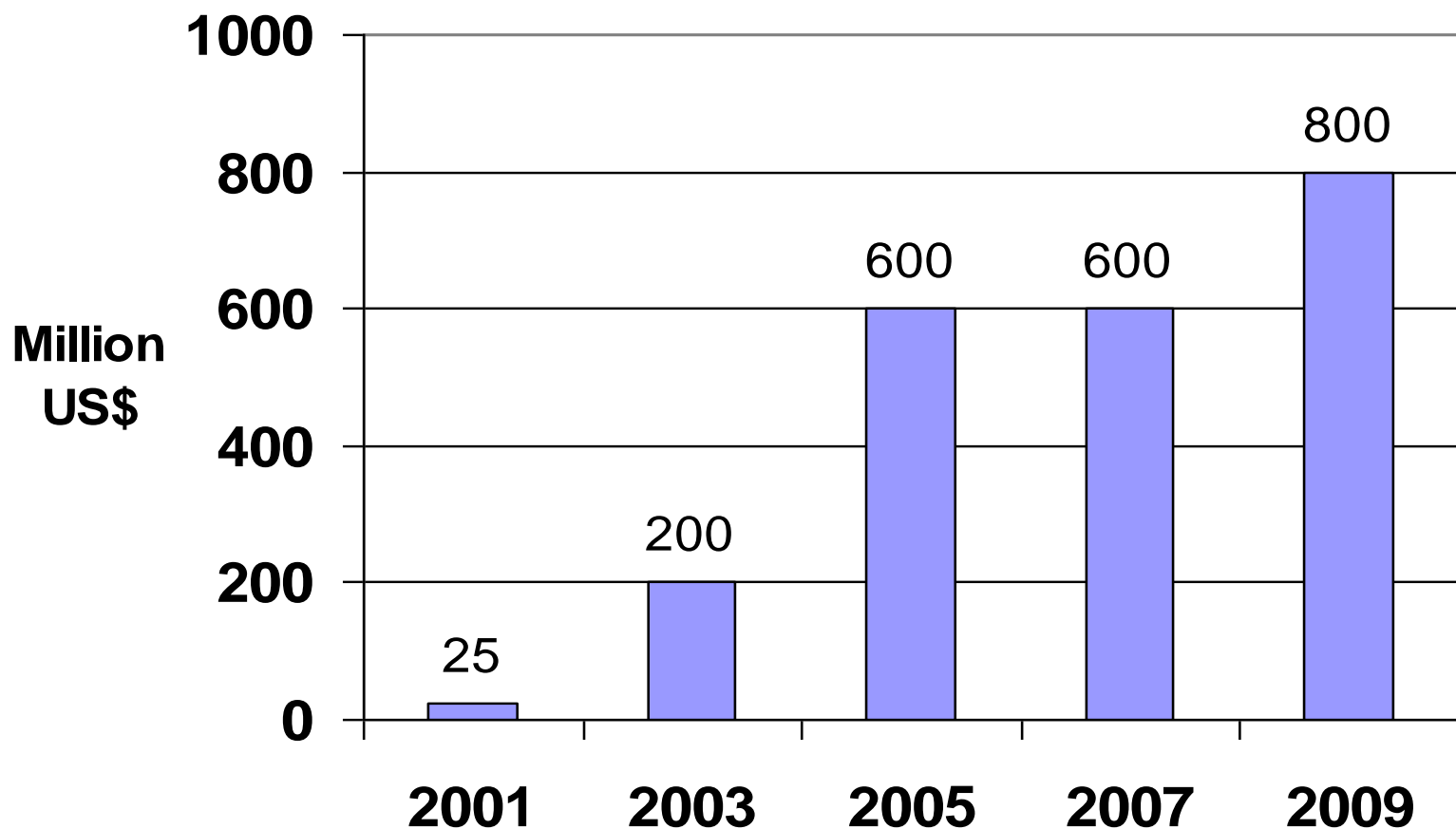
# Brazil: Spraying Soybeans



**Fungicides prevent losses of 44%**



# Brazil: Soybean Fungicide Market





# Africa:

## Maize as traditional food

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- Main food for 50% of the population.
- 65% of farms have shortages before next harvest.



# Maize Yields (Tons/hectare)

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**Africa**

**1.6**

**Global**

**4.5**



# Gray Leaf Spot on Maize Leaf





# Maize: Africa, Fungicides

**Sprayed**



**Unsprayed**

**Fungicides increase maize yields 27 to 54%**

Verma, 2001.





# Africa Transformed

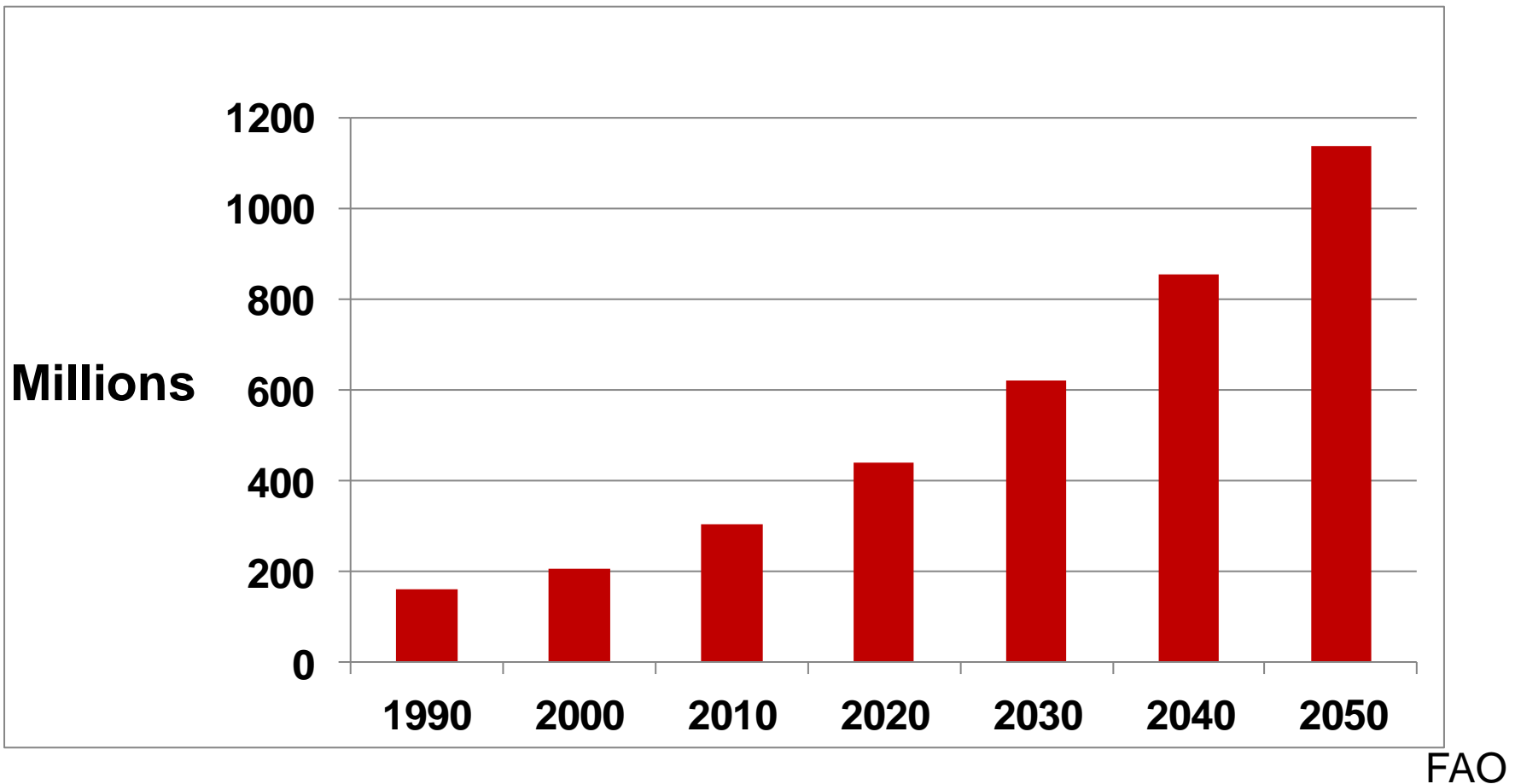


Rural to Urban





# Sub-Saharan Africa: Urban Population





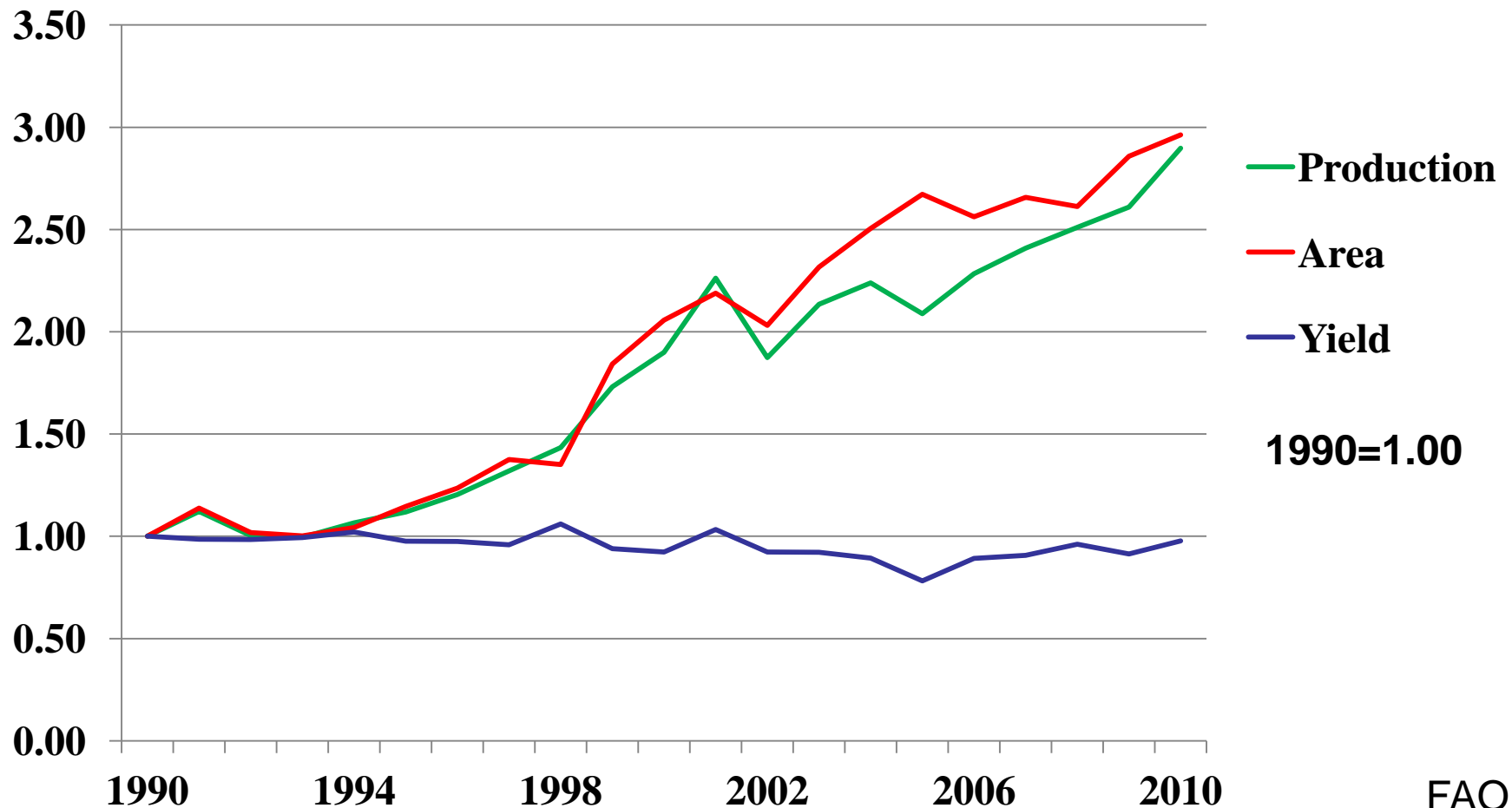
# Africa: Potato Consumption

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# Potato Production: Sub-Saharan Africa





# Kenyan Highlands





# Potatoes: Africa, Fungicides

**Sprayed**



**Unsprayed**

**Fungicide spray increases yield by 224%**



# Hand Weeding is the Predominant Weed Control Practice in Sub-Saharan Africa



**50-70% of the  
labor in crop  
production is  
spent weeding**

Chikoye, et al. 2007.





# Constraints on Timely Hand Weeding



- Women can be too tired or sick (malaria)
- Fields can be muddy
- Competing time demands: child care
- Pregnancy



# African Weed Control: Current Practice

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- **100 million hectares,  
100 million women**
- **200 hours/hectare**
  - **20 billion hours**
  - **20-100% yield loss**





# Crop Life Zambia Training Program



3,200 spray service providers were trained.





# Spray Service Provider: Zambia

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300% increase in herbicide sales in Zambia.



**Maize yield increased from 1.5-2.0 tons per hectare to as much as 4.5 tons per hectare.**

**CARE Zambia, 2011**



**Adoption of herbicide technology among female farmers has also brought behavioral change as most of them have vowed never again to weed their crops using hand hoes.**

**CARE Zambia, 2011**





**China would “undergo famine if pesticides were not used”. The warning has come in a recent Chinese Ministry of Agriculture document...**



# Japanese Rice

- **Famines due to rice blast**
  - 1695, 1783, 1833–1837
- **Last major rice blast outbreak : 1953**
- **Fungicides have prevented outbreaks since then**



**Rice blast**



**Monument to fungicides for rice  
blast control in Nankoku, Japan**



# Conclusion

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- **Pesticides are Essential for Feeding the World**
- **A significant increase in pesticide use would greatly improve international food security**



# **Weedy Crop Field: Africa**

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# **Weedy Crop Field: Africa**

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**Uncontrolled  
Weeds: A  
Major Cause  
of Hunger**







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